TRS FORM NO. 4 CODE NO. 41010104

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
TIGBAUAN RESEARCH STATION

ANNUAL REPORT

1. PROJECT: Mass production of P. monodon fry (Big Hatchery)
2. STUDY TITLE: Mass production of P. monodon fry and its economic aspect.
3. NAME OF INVESTIGATOR: Yoshitetsu Nukiyama
4. SOURCE OF FUNDING: SEAFDEC Aquaculture Department
5. a) Date approved:
   b) Date Assistance Granted:
   c) Date Started:
   d) Duration:
6. PERIOD COVERED BY THIS REPORT: January 1 to December 31, 1979
7. FINANCIAL REPORT:

	As Approved	Actual Expenditures	Balance
I. Personal			
II. Maintenance & Operating Expenses	₱252,000* ₱ 31,000**	₱ 63,917.95 22,064.50	₱ 935.50
III. Equipment Outlay			
IV. Capital Outlay			

* Approved budget for January to December 1979.
** Revised budget for July to December 1979.

8. REPORT OF ACCOMPLISHMENTS:

A. Abstract or highlights of research results

A total of 5,010,000 postlarvae was produced in 1979. The following experiments which were done during this period through the Hatchery Operation could give good results:

1) For the purpose of extension of harvest stage and simplification of rearing procedure - rearing of Mysis II and Postlarvae I of P. monodon and P. indicus up to P_{20} to P_{38} in the outdoor tank with blooming of Brachionus and adult Artemia.
2) Application of bread yeast which propagated in the seawater using brown sugar as supplemental food for the larvae of P. indicus and also Brachionus in the rearing tank.
3) Application of Tetracycline into the outdoor tank which was prepared with seawater for the transferring of Mysis I.
4) Reducing of the salinity rearing water and covering the tank using black cloth to prevent the blooming of diatom after Mysis I was transferred to outdoor tank during the dry season.
5) Application of 1.5 ppm of chlorine to kill blue green algae which contaminated the chlorella culture tank.

B. Objectives

1) To produce the postlarvae of P. monodon and other penaeid shrimps using large tank.
2) To refine Hatchery procedure to a stage where results are repeatable.
3) To simplify Hatchery procedure using large tank.
4) To study economics of large-scale Hatchery operation.

C. Materials and Method

The typical operation procedure was based on the techniques for the mass seed production of P. monodon in large tanks which developed in the SEAFDEC Hatchery over the last five years after many twists and turns, with some modifications and improvements, depending on the rearing situation in the tank.

For the basic Hatchery operation procedure, please refer to proposal control code 79-41010104.

For the purpose of re-using of used spawner for rematuration, transferred nauplii were used for production.

D. Results and Discussion

1) Monthly production

No. of Harvest ($x10^3$)	MONTH										
	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
P. monodon	610	584	544	1138	696	436	4	165	185	87	4,449
P. indious	0	217	180	94	0	0	70	0	0	0	561
TOTAL	610	801	724	1232	696	436	74	165	185	87	5,010

During the months of January and February, Hatchery operations were suspended due to repairs and maintenance of Hatchery equipment and facilities.

Actual Hatchery operation started March 7, when nauplii were first available.

2) Monthly nauplii supply

No. of nauplii ($x10^3$)/month	MONTH										
	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
P. monodon	4130	26850	22900	12826	7605	2640	360	3640	2930	300	84180
P. indious	0	890	370	340	0	0	1634	0	360	0	3614
TOTAL	4130	27740	23270	13165	7605	2640	1994	3640	3310	300	87794

a) Number of nauplii used in this table are matched with the harvest date of the respective postlarvae produced.

b) 95.9% of P. monodon nauplii come from Batan Hatchery until September 15th.

c) Since September 24th, nauplii from Tigbauan Gonadal Maturation Project were only used for operation.

3) Records of tank usage

	120-ton	50-ton	FGT
Mar-June	28	1 (4)	1
July-Dec	9	18 (7)	-
Average no. of stocked nauplii ($x10^3$)	2.070	425	-

In Parenthesis is P. indicus

Since July, usage of 120-ton tank was minimized due to shortage in the number of nauplii delivered.

In general, upon molting to mysis stage, larvae were transferred to newly propared tank. The following is the tank usage for transferring mysis by tank.

	200-ton	120-ton	50-ton	Nursely Pond
Tank usage	33	0	0	1

4) Result of Rearing

a) Total survival rate by stage from nauplius

P. monodon	N	Z1	M1	P1	Harvest
Mar-June	100%	80.2	42.5	23.9	4.3
July-Dec	100%	82.0	37.8	14.5	7.3
P. indicus					
Mar-June	100%	97.5	73.8	70.0	30.7
July-Dec	100%	88.4	32.9	-	11.2

Mortality of postlarvae stage of P. mondon was quite high during dry season due to high water salinity compared to rainy season. The following table survival rate between dry season and rainy season.

Stage	Naup-Z1	Z1-M1	M1-P1	P1-Harvest
Mar-Jun	80.2%	52.9	56.4	18.0
July-Dec.	82.0	46.0	38.5	50.2

b) The comparison of the survival rate by stocking density of nauplii of P. monodon in 120-ton tank:

Stocking density per 1-L water		31.0	48.8	30.3	43.8	38.2
S.R. (%)		0.02	1.8	0	0.005	0.5
(con't)	(cont'd)	43.6	33.0	7.9	15.5	10.1
		0.5	0.6	17.9	8.9	20.3
	(cont'd)	8.4	9.2			
		18.7	22.4			

It was very difficult to make a rotation of tank usage due to the haphazard production of nauplii. Since Hatchery has limited rearing tanks, it is impossible to stock with optimum density in the tank when too many nauplii were delivered.

c) Extension of harvesting stage (H29, H38, H54, H58, H60)

Mysis I were transferred to newly prepared tank which already propagated Brachionus with density of 30-50 inds using chlorella. No feeding was done until P_{15-20}, except propagated Brachionus and adult Artemia which naturally grew in the rearing tank. Chlorella were applied for feed of Brachionus from

time to time, and diatoms were bloomed naturally. After P_{15-20}, artificial diet (Kyowa) were fed until harvest. The following table shows the result of the experiment:

	Days of postlarvae	Stocking density per ton	Survival rate	Average body wt.	Tank
P. monodon	33 days	250	30.0%	0.100 g	NPI (360 ton)
"	26 days	1000	67.0%	0.050 g	200 ton
"	38 days	2700	34.3%	0.093 g	200 ton
P. indicus	20 days	400	88.0%	0.050 g	200 ton
"	22 days	1600	28.6%	0.067 g	200 ton

d) Rearing without Artemia (H39, H40)

Larvae of P. monodon were reared with only diatoms and Brachionus up to P_5 without feeding of Artemia. It could give only 2.0% and 0.02% survival rate.

e) Others

Application of cultured bread yeast in the seawater using brown sugar for the larvae of P. indicus could give good result (H14, 23, 26). Application for the transferring mysis could give good result (H24, 25). Reducing the salinity and covering over the tank using black cloth for rearing of mysis and postlarvae in outdoor tank during dry season was effective (H15) compared to (H9, 11).

The big problem of contamination of blue green algae in chlorella culture was solved using chlorine.

E. Conclusions and Recommendations

1) Total number of production of P. monodon fry was decreased in 1979 compared to last year (8,215,000) due to:

Big shortage of nauplii supply during rainy season that is the peak season for seed production of P. monodon, according to the results of last three years.

Poor production during dry season due to difficulty of controlling salinity of rearing water after mysis stage.

Recommendation:

a) Necessity of close coordination between Hatchery and nauplii production (It is more convenient that Hatchery and Broodstock were combined into one project under Crustacean Hatchery).

b) Utility of present Hatchery facility for seed production of P. indicus or other purpose during dry season.

2) Rearing of postlarvae using propagated Brachionus in the rearing tank is reasonable from the point of simplification of Hatchery procedure, but rearing with high stocking density by this method is still waiting for solution.

3) Others

a) There is no problem regarding mass production of diatoms and Brachionus for feeding of larvae at present.

b) It is still necessary to transfer mysis stage to newly prepared tank to avoid the big mortality at this moment.

c) Poor rearing conditions such as poor water quality and lack of food is believed to cause the larvae to weaken and be less resistant to bacteria and fungal infection.

d) Cultured bread yeast with seawater is effective as supplemental feed for larvae.

9. PROBLEMS ENCOUNTERED DURING THE YEAR

A) Operation

1) Low survival rate of seed production of P. monodon during dry season.

2) Difficulty of making rotation of tank usage.

3) Shortage of nauplii supply during rainy season.

4) Frequent occurrence of electric and engineering trouble.

B) Pirating of skilled Hatchery technicians by private companies

Taking a large view, the introduction of our techniques to other Hatchery by our trained technicians is greatly welcome, provided we all work for one goal, for the success of the prawn industry.

C) Inconsistency of selling system for harvested larvae to the private sector.

D) Uncertainty as to what is the future of Hatchery operation in SEAFDEC. It was doubtful whether Hatchery operation was receiving full cooperation and support in 1979. The present situation of Hatchery operations is worth looking into. The technique on mass seed production of P. monodon in large tank is basically established, but some problems including administrative aspects, are still awaiting solution. Specialization in study is all right, but what is more important is that each study must realize its responsibility in overall or final objective, that is, success of the prawn industry, not for the individual researcher himself.

Records attached: Table 1. Result of the production and its recipient.
Table 2. Summary of Hatchery operation.

Prepared and submitted by:

Y. NUKIYAMA
Japanese Expert

7 April 1980

Recommended by:

Program Leader

Project Leader

Table 1. Result of Production of Postlarvas and Its Recepient in 1979

Operation No.	Date	Stage	No. of fry Produced	No. of fry Delivered	Stage	Recepient	Remarks
H 1	Mar. 23	P_5	30,000	30,000	P_5	Cooperator	
H 2	29	P_5	580,000	200,000	P_5	Cooperator	
				370,000	P_5	Leganes	
				10,000	P_5	UP-SEAFDEC	
H 6-7	Apr. 5	P_5	490,000	300,000	P_5	Binangonan	
				190,000	P_5	Leganes	
H 8	14	P_8	217,000	217,000	P_8	Leganes	P. indicus
H 9	14	P_7	88,000	65,000	P_7	Villalus	
				23,000	P_7	Leganes	
H11	27	P_{12}	6,000	6,000	P_{12}	Leganes	
H13	May 4	P_5	40,000	40,000	P_5	Leganes	
H14	5	P_7	180,000	180,000	P_7	Leganes	P. indicus
H15	11	P_5	451,000	107,000	P_5	Villaluz	
				50,000	P_5	Cooperator	
				293,000	P_5	Leganes	
				1,000	P_5	UP-SEAFDEC	
H16	16	P_5	20,000	3,000	P_{13}	Leganes	
H18	30	P_5	33,000	32,000	P_5	Leganes	
				1,000	P_5	UP-SEAFDEC	
H19	June 3	P_5	379,000	258,000	P_5	Leganes	
				65,000	P_5	Cooperator	
				1,000	P_5	Ecology	
				55,000	P_5	Cooperator	
H22	8	P_6	396,000	246,000	P_6	Leganes	
				150,000	P_7	Cooperator	
H23	18	P_7	53,000	53,000	P_7	Leganes	P. indicus
H24	22	P_3	157,000	157,000	P_3	Leganes	
H25	29	P_2	206,000	156,000	P_2	Leganes	
				50,000	P_2	Cooperator	
H26	29	P_4	41,000	41,000	P_4	Leganes	P. indicus
H28	July 6	P_3	610,000	529,000	P_3	Leganes	

Table 1 - cont'd.

Operation No.	Date	Stage	No. of fry Produced	No. of fry Delivered	Stage	Recepient	Remarks
H28	July 6	P_3		80,000	P_3	Cooperator	
				1,000	P_3	Ecology	
H29	17	P_1	50,000	2,000	P_{36}	BFAR	
				3,000	P_{36}	Cooperator	
H31	25	P_3	9,000)	5,000	P_8	Binangonan	
H32, 33	27	P_5	27,000)				
H34	Aug. 1	P_5	401,000	290,000	P_5	Leganes	
				108,000	P_5	Jamandre	
				3,000	P_5	S I A	
H35	Aug. 9	P_5	35,000	35,000	P_5	Barangay Hatchery	
H38	Sept.19	P_{22}	35,000	30,000	P_{22}	Leganes	
				5,000	P_{22}	Artemia	
H39	14	P_5	4,000	4,000	P_5	Artemia	P. indicus
H41	22	P_5	35,000	35,000	P_5	FGT	
H44	Oct. 5	P_4	80,000	80,000	P_4	Barangay Hatchery	
H48	29	P_8	25,000	15,000	P_8	Leganes	
				10,000	P_8	Barangay Hatchery	
H49	30	P_6	60,000	60,000	P_6	" "	
H50	Nov. 10	P_6	60,000	60,000	P_3	" "	
H52	10	P_3	65,000	65,000	P_3	" "	
H54	Dec. 13	P_{26}	87,000	40,000	P_{28}	Cooperator	
H55	Nov. 29	P_8	60,000	60,000	P_8	Leganes	
TOTAL			5,010,000	4,870,000			
H56-58	Jan. 18	P_{34-38}	120,000	120,000	$P_{34,38}$	Leganes	
H59	Jan. 9	P_{23}	60,000	60,000	P_{23}	Leganes	P. indicus

*FGT - Fiberglass tank

Table 2. Summary of Hatchery Operation in 1979

Operation No.	Duration	Tank No.	Source of Nauplii	N	Z1	M1	P1	Harvest	Harvest stage	(%) S.R.	Remarks
H 1	3.7 - 3.23	CT11-12-FGT	Batan	890	710	230	100	30	P5	3.4	
	3.15- 3.29	CT 9-16	Batan	1780	1490	1490					
		CT10-16	Batan	1460	1570	940	1080	580	P5	17.9	
H3,4,5											P. indicus used FGT
H 6	3.23- 4.5	CT11-CT14	Batan	1820	1750	1390					
			Batan	2120	2250	2050					
H 7	3.23- 4.5	CT 9-CT14	Batan	1550	1030	600	2450	490	P5	8.9	
H 8	3.28- 4.14	FGT -CT 6	Banate	890	980	680	630	217	P8	22.3	P. indicus
H 9	3.29- 4.14	CT11-CT14	Batan	3100	3450	1360	1200	1	P7	0.02	Bacteria infection
	3.29- 4.14	CT10-CT16	Batan	4880	5240	2910	680	87	P7	1.7	
H10	3.30- 4.14	CT10-CT14	Batan	3030	2850	1330					Combine w/H9 in CT14
H11	4.6 - 4.27	CT10-CT16	Batan	1600	1500	260	Discarded				Z1 weak
		CT 9-CT16	Batan	1360	1120	440	540	6	P12	0.2	
H12	4.13- 4.27	CT11-CT14	Batan	3010	1810	1070	740	740	P4		P2 down
		CT12-CT16	Batan	4380	2270	1450	780	22	P4	0.005	P2 down
H13	4.21- 5.4	CT 9-CT13	Batan	3820	1830	1070					
		CT10-CT13	Batan	4360	2190	1280	2080	40	P5	0.5	P2 down
H14	4.22- 5.5	CT 6	TGM	370	350	330	330	180	P7	48.6	F. indicus used B. yeast
H15	4.28- 5.11	CT12-CT16	Batan	3450	1180	720					
		CT11-CT16	Batan	2080	840	340	990	451	P5	2.1	Reduce salinity in CT16
H16	5.6 - 2.29	CT 9-FGT	Batan	3300	2830	30	30	20	P5	0.6	Z1 weak
H17	5.13- 5.28	CT12-16-15	Batan	2880	2040	1270	1040				
		CT11-14-15	Batan	2460	1540	950	550				Fungal infection
H18	5.14- 5.30	CT 6	TGM	550	430	60	40	33	P3	6.0	Z1 weak
H19	5.20- 6.4	CT 9-CT14	Batan	1690	1550	800					
		CT10-CT14	Batan	1100	1100	940	1330	379	P5	12.7	
H20	5.26- 6.6	FGT-CT6	TGM	505	---	---	35	0	P3		Up to Mysis in FGT
H21	5.27- 6.8	CT11-CT15	Batan	2980	2360	1670	600	P3 discarded			Fungal infection
		CT12-CT13	Batan	2940	2480	1550	116	P2 discarded			Fungal infection

Table 2 - cont'd. -

Operation No.	Duration	Tank No.	Source of Nauplii	N	Z1	M1	P1	Harvest	Harvest stage	(%) S.R.	Remarks
H22	6.4 - 6.18	CT 9-CT16	Batan	1010	630	460					
		CT10-CT16	Batan	840	620	480	770	396	P6	20.3	
H23	6.4 - 6.18	CT5	TGM	170	130	110	115	53	P7	31.2	P. indicus used B. yeast
H24	6.12- 6.22	CT11-14	Batan	840	840	520	570	157	P3	18.7	Applied Tetracyline
H25	6.18- 6.29	CT 9-CT16	Batan	920	840	690	297	256	P2	27.8	Applied Tetracyline
H26	6.18- 6.29	CT 6	TGM	170	100	60	44	41	P4	24.1	P. indicus
H27	6.22- 7.6	CT10-14	Batan	2810	2340	800					
		CT11-14	Batan	1170	1880	1110	1150	610	P3	13.3	
H27	6.22- 7.5	CT 5	TGM	510	430	420	280	P3 discarded			Fungal infection
H29	7.9 - 7.17	CT9-CT4-NPI	TGM	200	670	230	50	50	P1	5.8	P33, 65,000
H30	7.5 - 7.17	CT 6-NPI	TGM	270	285	30					Combine with H29
H31	7.12- 7.27	CT11-4-GFGT	TGM/ Batan	540 +730	1430	220	100	9	P4	0.7	
H32	7.15- 7.27	CT9-5-FGT	TGM	390	130	60					
H33	7.17- 7.27	CT6-5-FGT	TGM	320	175	45	85	27	P3	3.8	
H34	7.18- 8.1	CT12-16	Batan	1360	760	630	530	401	P5	29.5	
H35	7.27- 8.9	CT10-5	Batan	1280	570	330	95	35	P5	2.7	
H36	8.23- 8.25	CT4	TGM/ Batan	110/ 100	0	Water container was low salinity					Did not molt to Z1
H37	8.23- 8.25	CT 9	Batan	1350	0						Did not molt to Z1
H38	9.24- 9.19	CT5-FGT-13	TGM	260	240	55	37	30	P3	11.5	P. indicus/P20, 35,000
H39	8.31- 9.14	CT4-AT	Batan	180	80	90	--	4	P5	2.2	Without Artemia
H40	9.5 - 9.19	CT5	TGM	180	150	95	--	0.4	P5	0.02	Without Artemia
H41	9.6 - 9.22	CT6	TGM	480	460	103	101	35	P5	7.3	P. indicus
H42	9.9 - 9.11	CT4	TGM	360	0	did not molt to Z1					P. indicus
H43	9.15- 9.24	CT4	TGM	538	0						P. indicus
H44	9.22-10.5	CT9-11	Batan	1510	840	120	110	80	P4	3.7	
H45	9.22- 9.25	CT5	TGM	450	0	did not molt to Z1					P. indicus

Table 2 - cont'd -

Operation No.	Duration	Tank No.	Source of Naupl'll	N	Xl	Ml	Pl	Harvest	Harvest stage	(%) S.R.	Remarks
H46	9.23-10.5	CT 6-11	Batan	660	290	140					Combine with H44
H47	10.3 -10.6	CT 4	TGM	380	Zl discarded						P. indicus
H48	10.14-10.29	CT 5-13	TGM	370	300	85	25	25	P8	6.8	
H49	10.18-10.30	CT 6-16	TGM	1100	1100	460	120	60	P6	5.5	
H50	10.26-11.10	CT 5-16	TGM	400	360	220	83	60	P6	7.1	
H51	10.28-11.20	CT 4-16	TGM	440	380	150					Combine with H50
H52	10.29-11.10	CT 6-13	TGM	580	510	330	--	65	P4	11.2	
H53	11.1 -11.14	CT11-6	TGM	1000	1290	610	Ml weak discarded				Zoea 6 days
H54	11.7 -12.13	CT4 -13	TGM	300	270	130		87	P26	29.0	
H55	11.14-11.29	CT 5-16	TGM	140	190	130	93	60	P3,8	9.8	
H56	11.16-11.29	CT 4-16	TGM	370	290	180					Combine with H55
H57	11.24- 1.9	CT 4-CT15	TGM	250	--	3	--	0.3	P53		
H58	12.1 - 1.18	CT 5-CT16	TGM	650	520	350		120	P34, 38	12.2	
H59	12.5 - 1.18	CT 4-16	TGM	330	100	100					Combine with H58
H60	12.7 - 1.9	CT 6-CT15	TGM	380	290	210	--	60	P22	15.8	P. indicus

Unit of Larvae: 1,000 head

TGM - Tiqbauan Gonadal Maturation

AD-ODR Form No.6 Control Code 41010104

Southeast Asian Fisheries Development Center
AQUACULTURE DEPARTMENT
Tigbauan, Ileile

ANNUAL REPORT

1. Title: Mass production of P. monodon fry and its economic aspect.

2. Proponent(s): Agency: SEAFDEC Station: Tigbauan
Research Leader Yoshitetsu Nukiyama

3. Cooperating Agency, if any: None

4. a) Date Approved: _____ c) Date Assistance Granted (if Applicable) _____
b) Date Started : _____ d) Duration : _____

5. Period Covered by this Request: January 1 to December 31, 1978

6. Financial Status Source(s) _____

	As Approved	Actual Expenditures	Balances
I. Personal Services			
II. Maintenance and Operating Expences		₱68,195.25	
III. Equipment Outlay		8,115.22	
IV. Capital Outlay			
T o t a l	₱125,875.00	₱76,310.47	₱49,564.53

7. Report of Accomplishments:

A total of 8.215 million postlarvae was produced in 1978.
Brief summary of operation in 1978 is shown as follows:

i. Monthly production

MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
No. of Harvest ($X10^3$)	195	123	947	29	1,412	1,780	2,013	1,134	561	0	6,215

a. During the months of Japnuary and February, the hatchery was not in operation for repar and maintenance of facilities and equipment.

b. Hatchery operation started March 10 and ended December 5.

c. Average monthly production was 913,800.

ii. Monthly spawner, eggs and nauplius supply

MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
No. of Spawner Supply	75	85	120	103	53	160	104	195	58	0	935
No. of Spawner Used	67	74	100	91	40	144	88	180	55	0	841
No. of Egg Supply ($X10^3$)	0	0	0	0	0	0	480	810	0	0	1,290
No.of Nauplius Supply ($X10^3$)	1,030	0	290	220	650	0	1,460	1,620	1,620	190	5,460

a. 10.0% of the total supply of spawer was dead on arrival.

b. 91.5% came from the broodstock, with only 8.5% wild.

c. Maturity of spawner- 25.8% of stage 4, 41.9% of stage 3, 32.3% of others.

d. Total spawner supply was only 54.1% of last year.

e. The average number of used spawner per operation was 22.1 pcs.

f. The average number of manuplius per spawner was 69,300; production per spawner was 8,625 post larvae.

iii. Records of tank usage and average number of nauplius by tank

Tank	200 ton	120 ton	50 ton	FGT	TOTAL	Average No. of Nauplius ($X10^3$)
Spawner used	2	26	10		38	1,294
Second spawning		9	10	2	21	294
Nauplius used		5	9		14	390
Egg used		2	2		4	322
Total	2	42	31	2	77	

a. Out of 22 trials of second spawning, only 11 trials was spawned.

b. In general, upon molting to mysis stage, larvae were transfered to new prepared tank.

c. Tank usage for transferring Mysis by tank.

Tank	200 ton	120 ton	50 ton	FGT	TOTAL
Tank usage	22	3	3	3	31

iv. Results of Rearing

a. Total survival rate by stage from Nauplius

	Nauplius	Zoea_I	Mysis I	Postlarvae 1 day	Harvest
Total No. ($X10^3$)	65,220	61,890	27,266	13,666	8,215
Survival rate (%)		95.2	41.9	21.0	12.6

b. Monthly survival rate from Nauplius

	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Total No. of Nauplius ($X10^3$)	4,390	5,440	4,690	8,610	4,510	5,020	12,780	10,520	9,070	190	65,220
No. of Harvest ($X10^3$)	195	123	947	29	1,412	1,780	2,013	1,135	581	0	8,215
Survival Rate (%)	4.4	2.3	20.2	0.3	31.3	35.5	15.8	10.8	6.4	0	12.6

Note: Total number of nauplius used in this table are muched with the harvest date of the respective postlarvae produced.

c. Main cause of mass mortalities

Months of March and April were due to fungal infection; June and Spetember were bacteria infection; and October, November were bad weather conditions with fungal infection, respectively.

d. The record production of 1,110 million postlarvae harvest from one tank was attained on August 16, 1978 with highest survival rate of 60.7%.

e. Difference of survival rate of spawner, nauplius and egg used:

Spawner used	12.7%
Transferred Nauplius used	17.6%
Transferred Eggs used	0

There were higher survival rate of transfered nauplius used than spawner used, but stocking density were quite low compared to spawner used.

f. Transfering of Mysis stage- 79.3% of the total number of Mysis produced were transfered to outdoor 200 ton tank. Out of 22 trials of transfering to outdoor tank, 20 trials were succeeded to harvest with survival rate of 35.0% from Mysis 1. The average number of production per one ton water was only 1,720 fry and highest production was 7,400 fry per one tons water in 200 ton tank.

8. Problems and Recommendations:

i. The technique on the mass seed production of P. mondon in large tanks is basically established but there are still some factors which have an influence upon weather conditions.

a. Insure fresh water supply, especially during dry season.

b. Insure a good condition of sea water supply for rearing water and feed culturing water during the typhoon seasons.

c. Study on the circular filtering system for rearing water in large tank using biological filter.

d. Establishment of the stabilized mass culture technique of Diatons during rainy seasons.

e. Study on the supplemental feed which can preserve for a long time (artificial feed, frozen feed, etc.) in large tank

ii. The present techniques of Hatchery operation needs 24-hour management and the work has been made a risky attempt due to be pressed with number of production.

a. Development for more repeatable and scope for operational procedure.

b. Simplification for operational procedure with more economical.

c. Consideration for a safety countermeasure.

d. To draw up a hatchery operational manual using large tanks following the basic data which are gathered through the routine operations.

e. Study on the possibility of the economics of large-scale Hatchery as industry in Southeast Asian countries.

iii. The average number of production per 1-ton water was only 1,720 fry. This is still very far from our goal which is 10,000 fry per 1 ton water, and also survival rate was low.

a. Increment of number of spawner supply from broodstock project.

b. Improvement of spawner and nauplius and egg transport technique.

c. Reconsideration of collecting spawners from the wild.

d. Through going prevention for bacteria and fungal infection.

iv. After harvest

a. Improvement of fry transport techniques from Hatchery down to the end users.

b. Examination to extend harvest stage from P5 to P10.

v. Rationalization of seed production of P. monodon. The peak of production was only from the month of July up to October according to the result in 1977 and 1978. Maybe, in the near future, it is possible to concentrate to produce P. monodon fry only in the season of the peak of production so that during the other months, present hatchery facilities can be utilized for other animal production.

9. Personnel

Name	Designation
1. Yoshitetsu Nukiyama	Japanese Researcher
2. Felix Gutierres	Research Assistant
3. Godofredo Padua, Jr.	Research Assistant
4. Bernardo Padayao	Research Aide
5. Rosemarie Caballero	Fisheries Technician
6. Erlinda Cañaz	Fisheries Technician
7. Herminie Pelobello	Fisheries Aide
8. Arnel Abaricio	Fisheries Aide
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11. Jimmy Gajito	Fisheries Aide
12. Neri Gentelizo	Fisheries Aide
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16. Arthur Sabayle	Fisheries Aide
17. Elmer Sumbing	Fisheries Aide
18. Vicente Torrigue	Fisheries Aide
19. Rafael Geonigo	Fisheries Aide
20. Eugenie Tabigoon	Fisheries Aide

10. Records attached:

i. Table 1. Result of the production and its recipient.
ii. Table 2. Record of spawner, mauplius and eggs received.
iii. Table 3. Summary of Hatchery Operation.

Prepared and Submitted by:

YOSHITETSU NUKIYAMA
Proponent

Japanese Researcher
Designation

January 15, 1979
Date

Recommended by:

WILFREDO G. YAP
Program Leader

JOSE A. EUSEBIO
Director of Research

Table 1. Result of the Production of Postlarvae and its Recipient

Operation No.	Date	Stage	No. of fry Harvested	Recipient	Monthly Production
H 1	3.22	P3,4	195,000	Leganes	195,000
H 3	4. 6	P3,4	123,000	Leganes	123,000
H 5	5.13	P18	7,000	Leganes	
H 6	5.13	P4,5	612,000	Leganes	
H 7	5.20	P4,5	328,000	Leganes, P4,5, 308,000; Tahiti, P13, 6,000	947,000
H 8	6.19	P18	1,000	Leganes	
H 9	6.19	P11	16,000	Leganes	
H10	6.22	P5	12,000	Leganes	29,000
H12	7. 6	P4,5	415,000	Leganes, P4,5, 395,000; Tahiti, P17, 2,000; Zamboanga, P19, 12,000	
H13	7.11	P5,6	867,000	Leganes	
H15	7.27	P4,5	130,000	Leganes, P5, 100,000; Zamboanga, P18, 35,000	1,412,000
H16	8. 7	P5,6	103,000	Leganes	
H17	8.18	P3,4	57,000	BFAR, P15, 30,000	
H18	8.19	P4,5	1,110,000	Leganes, P4,5, 1,100,000; Hawaii, P15, 3,000	
H19	8.26	P4,5	510,000	Leganes, P4,5, 400,000; P19, 5,000	1,780,000
H20	9. 2	P5,6	346,000	Leganes, P5,6, 316,000; P21, 3,000	
H21	9. 9	P5,6	350,000	Leganes, P5,6, 300,000	
H22	9.16	P4,5	59,000	Leganes	
H23	9.23	P4,5	348,000	Leganes	
H24	9.30	P4,5	910,000	Leganes	2,013,000
H26	10.15	P4,5	450,000	Leganes	
H28	10.18	P5,6	595,000	Leganes, 535,000; Fernandes, 60,000	
H29	10.26	P4,5	90,000	Leganes	1,135,000
H30	10. 3	P7,8	121,000	Leganes	
H31	11. 7	P7,8	70,000	Binangonan	
Expt.	11.10	P4,5	158,000	Leganes	349,000
H32	11.15	P4,5	50,000	Leganes	
H33	11.24	P5,6	179,000	Leganes 119,000; Binangonan 60,000	
Expt.	11.24	P3,4	3,000	Leganes	581,000
				Total	8,215.00

Table 2. Records of Spawners, Nauplius and Eggs Received
(March 10, 1978 to November 6, 1978)

Date	OP No.	Total Supply	Source	Ablated	Wild	DOA	Used Spawner	Maturity			No. of Nauplius X10^3		Remarks
								S4	S3	Others		( ) Naups. Rec'd	
3.10	H 1	Eggs Naups.	Batan									(1,030)	46 spawners were used in Batan
3.15	H 2	37	Batan	37	0	2	35	33	2	0	3,360		
3.21	H 3	38	Batan	38	0	4	32	4	11	17	3,910		
Sub-Total		75		75	0	6	67	37	13	17	7,270	(1,030)	
4. 6	H 4	26	Batan	26	0	1	20	4	16	0	880		5 pcs. given to other project
4.14	H 5	25	Batan	25	0	1	24	2	10	12	850		
4.28	H 6	34	Batan	34	0	2	30	4	8	18	1,460		
Sub-Total		85		85	0	4	74	10	34	30	3,190		
5. 6	H 7	46	Batan	46	0	2	44	8	20	16	3,030		
5.20	H 8	32	Batan	32	0	9	23	5	8	10	720		
5.24	Expt.Naup.		BGY									(290)	6 spawners were used in wet Lab ext.
5.28	H 9	42	Batan	42	0	9	33	4	15	14	3,420		
Sub-Total		120		120	0	20	100	17	43	40	7,170	(290)	
6. 5	H10	48	Batan	39	9	2	45	11	14	20	3,960		
6.15	H11	Naup.	Batan									(220)	34 spawuers were used in Pandan
6.19	H12	39	Batan	36	3	6	33	6	19	8	1,790		
6.26	H13	16	Batan	16	0	3	13	4	2	7	1,790		
Sub-Total		103		91	12	11	91	21	35	35	7,540	(220)	

Table 2 (Cont'd)

Date	OP No.	Total Supply	Source	Ablated	Wild	DOA	Used Spawner	Maturity			No. of Nauplius X10^3		Remarks
								S4	S3	Others	( ) Naups. Rec'd		
7. 4	H14	39	Batan	39	0	4	29	4	14	11	530		6 spawners given to other Project
7.13	H15	Naup.	Batan									(400)	24 spawners were used in Pandan
7.22	H16	14	Batan	14	0	3	11	2	9	0	250		
7.25	H17	Naup.	BGY.									(250)	6 spawners were used in Wet Lab ext.
Sub-Total		53		53	0	7	40	6	23	11	780	(650)	
8. 3	H18	20	Batan	14	6	0	19	6	13		1,830		1 pc. given to other Project
8.10	H19	32	Batan	30	2	2	27	4	14	9	2,690		3 pcs. given to other Project
8.17	H20	33	Batan	29	4	3	30	7	13	10	3,750		
8.24	H21	40	Batan	35	5	2	38	5	22	11	2,370		
8.31	H22	35	Batan	35	0	3	32	10	15	7	1,500		
Sub Total		160		143	17	10	146	32	77	37	21,140		
9.11	H23	Naup.	Batan									(1,460)	Spawned in Pandan
9.15	H24	25	Batan	22	3	3	20	3	10	7	1,650		2 pcs. given to other Project
9.22	H25	27	Batan	27	0	2	23	5	12	6	1,570		1 pc. given to other Project
9.21	Expt.	Eggs	Batan									(480)	3 pcs. spawned in Pandan
9.29	H26	54	Batan	37	17	3	45	23	17	5	5,670		6 pcs. given to other Project
Sub-Total		106		86	20	8	88	31	39	18	8,890	(1,940)	

Table 2 (Cont'd.)

Date	OP No.	Total Supply	Source	Abla-ted	Wild	DOA	Used Spawner	Maturity			No. of Nauplius X10^3		Remarks
								S4	S3	Others	( ) Naups. Rec'd		
10. 2	H27	Eggs Naup.	Batan Ozamis									(590)	
10. 2	H28	17	Batan	0	17	0	17	3	8	4	1,150		7 pcs. used spawners from Ozamis were combined
10. 2	H28	Eggs	Batan									(150)	25 pcs. spawned in Batan
10. 9	H29	65	Batan	65	0	4	61	28	24	11	2,960		
10.15	H30	44	Batan	44	0	4	40	4	16	20	1,100		
10.24	H31	Eggs Naup.	Batan									(660)	Spawned in Batan
10.29	Expt.	Naup.	GMP									(520)	6 spawned in Wet Lab Ext.
		Naup.	GMP									(510)	Naup. from GMP added with second spawning
10.30	H32	69	Batan	54	15	7	62	111	23	28	1,730		3pcs. spawned in Wet Lab.Ext.
Sub-Total		195		163	32	15	180	44	71	65	6,940	(2,430)	
11.. 5	Expt.	Naup.	GMP									(670)	5 pcs. spawned in Wet Lab.Ext.
11. 6	H33	38	Batan	38	0	3	35	11	7	17	2,950		
11.11	Expt.	Naup.	GMP									(220)	2 pcs. spawned in Wet Lab.Ext.
11.14	H34	20	Batan	20	0	0	20	8	10	2	310		
11.25	Expt.	Naup.	GMP									(210)	1 pc. spawned in Wet Lab. Ext.
Sub Total		58		58	0	3	55	19	17	19	3,260	(1,100)	

Table 2 (Cont'd.)

Date	OP No.	Total Supply	Source	Ablated	Wild	DOA	Used Spawner	Maturity			No. of Nauplius X10^3 ( ) Naups. Rec'd	Remarks
								S4	S3	Others		
12. 1 Expt.Naup.			GMP								(190)	1st day - 160 N3 2nd day - 55 N3 spawned in Wet Lab. Ext.
Sub-Total											(190)	
GRAND TOTAL		955		874	81	84	841	217	352	272	57,180 (7,850)	

DOA Dead on Arrival

BGY Barangay Hatchery Project

GMP Gonadal Maturation Project

Table 3. Summary of Hatchery Operation (March 10, 1978 to November 10, 1978)

OP No.	Duration	Tank No.	Used Spawner	No. of Larvae X10^3					S.R. (%)	Remarks
				N3	Z1	M1	P1	Harvest		
H1	3.10- 3.22	CT 9	Noup.	1,030	730	700	270	195	18.9	M1 w/ fungal inf.
H2	3.15- 3.29	CT16	35*	3,260	3,070	2,450	2,070	0	0	M1 w/ fungal inf. P2 discarded, salinity 34-35 ppt.
	3.16- 3.24	CT11	S.SP	100	100	0			0	w/fungal inf. 23 discarded.
H3	3.21- 4.6	CT-15-CT9	32*	3,810	4,100	990	270	123	3.2	Z3 w/ fungal inf. Changed tanks and applied Malachite green (0.06 ppm).
	3.22- 3.30	CT10	S.SP	-	100	0			0	w/ fungal inf. Z2 discarded.
H4	4.6 - 4.14	CT10	20*	850	900	0			0	23 high mortality. Lack of distoms, Zoea 6 days
	4.15- 4.16	CT11	S.SP	0						Did not spawn.
H5	4.14- 4.19	CT11	24*	630	580	0			0	Z2 discarded. Naups weak.
	4.15- 5.13	CT9,CT5 FGT	S.SP	200	-	-	78	7	3.5	Harvested P18
H6	4.28- 5.13	CT10-CT16	30*	1,010	700	730				
	4.29- 5.13	CT11-CT16	S.SP	450	210	200)	890	612	41.9	P2, 3 w/ fungal inf.
H7	5.7 - 5.22	CT 9-CT13	44*	3,030	2,350	1,460	700	328	10.8	Z1 w/ fungal inf.
	5.8 - 5.9	CT 3	S.SP	0						Did not spawn
H8	5.20- 6.18	CT9-FGT	23	630	630	100		1	0.1	Naup. weak. 13
	5.21- 6.18	CT10-FGT	S.SP	90	100	55)	-	1	0.1	Harvested P1i
Expt.	5.25- 6.1	CT5	Naup.	290	270	0			0	Z3 discarded
H9	5.28- 6.19	CT11-FGT	33	3,420	3,550	150	-	16	0.5	Z1, 2 High mortality, bacteria inf.
	5.29- 5.30	CT 4	0							Did not spawn

(Table 3 (Cont'd.)

OP No.	Duration	Tank No.	Used Spawner	No. of Larvae X10^3 N3	Z1	M1	P1	Harvest	S.R. (%)	Remarks
H10	6.5- 6.14	CT9	23*	840	680	0			0	Z3 discarded. Bacteria inf.
	6.5- 6.14	CT10-CT4-FGT	22*	3,000	2,900	22				Z2 high mortality. Bacteria inf. Applied Tetracycline (0.3 ppm) after combined in CT4
	6.6- 6.14	CT5-CT4-FGT	S.SP	120	60	80		12	0.4	
H11	6.15-6.20	CT11	Naup.	220	-	0			0	Z2, 3 discarded. Naups. weak.
H12	6.19-7.6	CT9 -CT16	17	810	1,080	630				
	6.19-7.6	CT10-CT16	16*	870	860	20				Z1 weak, bacteria inf.
	6.20-7.6	CT 5-CT16	S.SP	110	180	186	420	415	23.2	
H13	6.26-7.11	CT 4-CT13	13*	1,790	1,510	1,210	1,046	867	48.4	Zoea applied Tetracycline
H14	7.4 -7.13	CT9-FGT	29*	530	460	140	-			80,000 M2 given to Pathology for experiment.
	7.5 -7.6	CT5	S.SP	0						Did not spawn
H15	7.13-7.27	CT4-CT9	Naup.	400	240	220	300	130	32.5	
H16	7.22-8.7	CT4-CT10	11*	250	230	210	150	103	41.2	Z1 w/ fungal inf.
	7.23-7.24	CT5	S.SP	0						Did not spawn
H17	7.25-8.18	CT5-CT4	Maup.	250	330	140	60	57	22.8	Z1 w/ fungal inf.
H18	8.3 -8.19	CT9-CT16	9*	750	760	730				
	8.3 -8.19	CT11-CT16	10*	1,080	1,020	970	1,050	1,110	60.7	
	8.4 -8. 5	CT5	S.SP	0						Did not spawn
H19	8.10-8.26	CT10-CT15	27*	2,590	2,450	1,010				
	8.11-8.26	CT5-CT15	S.SP	100	120	285	732	510	19.0	
H20	8.17-9. 2	CT9-CT16	15*	1,360	1,270	1,170				M2, high mortality
	8.17-9. 2	CT11-CT16	15*	1,890	1,690	1,580				M1, high mortality
	8.18-9. 2	CT14-CT16	S.SP	500	540	140	420	346	9.2	

Table 3 (Cont'd)

OP No.	Duration	Tank No.	Used Spawner	No. of Larvae X10^3 N3	Z1	M1	P1	Harvest	S.R. (%)	Remarks
H21	8.24- 9. 9	CT10-CT16	20*	910	760	860				
	8.24- 9. 9	CT 4-CT 4	7*	260	170	80	470	350	29.0	
	8.24- 8.30	CT6	11*	1,200	630	0				Z2 discarded, Naup. weak.
H22	8.31- 9.8	CT9	16*	520	590	0			0	Z3 discarded, bacteria inf.
	8.31- 9.8	CT11	16*	800	600	0			0	Z3 discarded, bacteria inf.
	9.1- 9.16	CT4-CT16	S.SP	180	200	170	65	59	32.8	
H23	9.11- 9.23	CT10-CT15	Naup.	1,460	1,260	720	200	348	23.8	
H24	9.15- 9.30	CT11-CT16	20*	1,650	1,500	1,200	1,180	910	55.2	
H25	9.21-10.5	CT6 -CT15	Eggs	480	430	180				1.ppm Tetracycline Tyhoon 9.26-29.
	9.22-10.5	CT5 -CT15	12	1,570	1,210	1,200	480	0	0	w/ fungal inf. P2, 3 discarded
	9.22- 9.26	CT4	11	0						Very few naup. discarded.
H26	9.29-10.3	CT4	16	1,890	270	0			0	Z1 w/fungal inf. discarded.
	9.29-10.15	CT11-CT16	29	3,780	2,260	1,480	660	450	11.9	Tyhoon, used stocking water for spawning
	9.30-10. 2	FGT	S.SP	610						Naup. combined w/ CT9 of H27
H27	10. 2-10. 3	CT6	Naup.	430	160				0	Z1, 2 discarded, w/ fungal inf.
	10. 2-10. 3	CT9-CT16	Eggs	160	770	120				Combined w/ CT11 of H26, Tyhoon 10.8-10.15
H28	10. 2-10. 3	CT5	Eggs	150	0					Few hatching rate, discarded
	10. 2-10. 4	CT10-CT15	24	1,150	1,020	740	910	595	51.7	
	10.3 -10. 4	FGT	S.SP	0						Did not spawn.

Table 3 (Cont'd.)

OP No.	Duration	Tank No.	Used Spawner	No. of Larvae X10^3					S.R. (%)	Remarks
				N3	Z1	M1	P1	Harvest		
H29	10. 9-10.26	CT 4-CT16	21	1,340	1,380	120				Z1 w/ fungal inf. Salinity 27-28 ppt.
	10.9 -10.26	CT 5-CT16	20	980	930	310				Z3 w/ fungal inf. due to typhoon
	10.9 -10.26	CT 6-CT16	20	640	830	340	130	90	2.9	Z1, 2 w/ fungal inf.
	10.10-10.26	CT12-CT16	S.SP	150	180	few	130	90	2.9	
H30	10.15-11. 3	CT 9-CT15	40	880	810	500				
	10.16-11. 3	CT11-CT15	S.SP	220	110	110	330	121	11.0	
H31	10.24-11. 7	CT10-15-4	Naup.	620	480	290	160	70	11.3	
	10.24-10.27	CT12	Eggs	40	0					Low hatching rate, w/ fungal infection
Expt.	10.29-11.10	CT 6-CT15	Naup.	520	460	365	223	158	30.4	
H32	10.30-11.15	CT11-CT15	62	1,730	1,600	820				M1, 2 w/ bacteria inf.
	10.31-11.15	CT 9-CT16	S.SP	510	740	300	120	50	2.2	
Expt.	11. 5-11. 4	CT5	Naup.	670	460	220	0			M2, 3 discarded, w/ bacteria inf.
H33	11. 6-11.24	CT12-CT15	35	2,470	2,560	1,050	210	108	4.4	M2, 3 w/ fungal inf.
	11. 7-11.24	CT10-CT16	S.SP	480	550	340	60	71	14.8	
Expt.	11.11-11.24	CT4-FGT	Naup.	220	30	30	12	3	1.4	
H34	11.14-11.27	CT11-CT 6	20	310	290	60	0			M3 discarded, w/ fungel inf.
Expt.	11.25-11.28	CT5	Naup.	210	20					Z2 discarded, did not molt to
Expt.	12. 1-12. 5	CT-4	Naup.	190	100					Z1 discarded Z1 very weak w/ temp. 24.8-25.8°C

*Mark means used treated spawner

S.R.: Survival rate from Naups
S.SP: Second spawning
FGT : Fiberglass tank

AQUACULTURE DEPARTMENT
Southeast Asian Fisheries Development Center
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ANNUAL REPORT: Hatchery Operation in 1977

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Mansoy, J.	Fish. Aide
Pelobello, H.	Fish. Aide
Sabayle, A.	Fish. Aide
Sumbing, E.	Fish. Aide
Tabigo-on, E.	Fish. Aide
Torrento, J.	Fish. Aide
Torrigue, V.	Fish. Aide

I. Introduction

The hatchery facilities at Tigbauan was designed constructed primarily for the mass seed production of Penaeus monodon. As such it has produced postlarvae to supply the Department's shrimp pond in Leganes as well as some private operators. Because of the size

of its tank, it is really ill-designed for systematic research following classical experimental designs. Although it should be viewed mainly as a service unit, its potential for producing research results in terms of refined techniques for the main production of P. monodon fry cannot be discounted.

II. Hatchery Facilities

a) Outdoor 200-ton rearing tanks with mechanical agitator
   2 tanks used for Diatom culture up to August

b) Indoor 120-ton rearing tanks
   4 tonks with mechanical agitator since November
   2 tanks used for seawater reservoir

c) Indoor 50-ton rearing tanks
   3 tanks used as filtered seawater reservoir
   1 tank used for experiment on gonadal maturation
   2 tanks used for experimental rearing

d) 360-ton open tank
   1 tank used for Chlorella culture
   1 tank used for Rotifer culture

e) 40-ton algal tank with sand filter system for concentrating diatoms since August

f) Store room

g) Microscope and lounge room

h) Office

III. Procedure of Hatchery Operation

a) Larval Rearing

Basic techniques on the mass seed production of P monodon in the large tank which had been established in 1976 were followed for the 1977 operation. The typical operating procedure was as follows:

1) The tanks are washed, scrubbed, sterilized by 15 ppm of Calcium Hypochlorite and air dried.

2) In the evening the spawners are stocked directly into the rearing tank with double-filtered seawater 30 to 40 cm deep and provided with aeration. In the following morning, after spawning has taken place, the spawners are taken out with a scoop net.

3) The mechanical agitator is used right after the spawners are taken out of the rearing tank.

4) Layers of black netting materials are used to lower light intensity to less than 5000 lux up to Mysis stage to prevent excessive diatom bloom. Light intensity is gradually increased to 10,000 to 15,000 lux at the mysis and postlarvae stage by removing one layer of black net at a time.

5) The larvae are fed starting at the Zoea stage according to the schedule in Table 1.

6) New double-filtered seawater is added daily into the rearing tank depending upon larval density and diatom density until the full capacity of the tank is reached. Water is changed at the rate of 50-70% of total volume daily depending upon the condition of the rearing water until harvest.

7) The larvae are harvested on the 5th day of the postlarval stage. The number of larvae harvested is estimated by taking at least five one-liter aliquots from 300 liter fiberglass holding tanks after vigorous agitation.

b) Culture and Preparation of Feed

The culture of planktonic organisms such as diatoms and rotifers is an integral part of hatchery management. Timing is very important. An attempt in 1976 to establish a separate unit to serve the hatchery's natural feed requirement was scuttled

because of disastrous results. The present system of having a separate unit to maintain only the starter stock was evolved soon after.

1. Mass Culture of Diatoms (Chaetoceros sp.)

Ten algal tanks each with 40-ton capacity are used for the mass culture of diatoms. In the evening, seawater is admitted up to 70% of its capacity and sterilized using 8-15 ppm of calcium hypochlorite with airlifted aeration. After 12 hours sodium thiosulfate is used to neutralize the active chlorine. Commercial fertilizer is applied as follows:

46-0-0	50-100 ppm
16-20-0	10- 20 ppm

Starter of Chaetoceros is added at a density of 100,000 cells per cc. After one to three days Chaetoceros sp. reaches a density of 500-1000 X 10^3 cells per ml. The diatom is now ready for use. However, 20% of the diatom culture is left as starter for the next culture. Seawater is added again and fertilizer applied. The second bloom of diatom is totally utilized. The tanks are cleaned and prepared for the next run. By this procedure diatoms could be maintained to supply the hatchery for 2 days. At least one algal tank is as starter stock from 10 one ton fiberglass tank everyday. Ageing and contamination of diatoms cultured in the algal tank limits its use to only one time. Original starter is obtained from monospecific culture in the Phycology laboratory, which is propagated in 100 liter aquaria to be used as starter for the fiberglass tanks. New cultures in the fiberglass tanks are set up every morning using the same concentration of fertilizer.

2. Use of Tetraselmis

On November, 1976, the flagellate Tetraselmis was mass cultured for the first time and tried for mass larval rearing. The larvae fed with Tetraselmis were initially more healthy and robust than those fed only on Chaetoceros. The main problem encountered was in the concentration of the flagellates using the conventional sand filters. Tetraselmis has a more pliant cell wall compared with the relatively-rigid silicious diatom. Despite of its larger size Tetraselmis passes through the present sand filter system. They have to be fed direct, which means including culture nutrients and metabolites. Survival of the larvae up to postlarvae was still high but they developed reddening on the second day. Unless we can develop a system of concentrating Tetraselmis, its use for larval rearing might be severely limited merely as a supplement.

3. Mass Culture of Marine Rotifer (Brachionus plicatilis)

Mass culture of Brachionus plicatilis is done using the open tank with a capacity of 360 tons. Chlorella is first propagated in the tank up to 1/4 its capacity. When the Chlorella has bloomed to a density of 15-20 million cells per cc, rotifer starter is added. Changes in the color of rearing water or transparency of the water could be used as an indicator of rotifer propagation. At first, the color of the medium is dark green, turning yellowish (as rotifers start to propagate). When the medium becomes transparent, the maximum density of Brachionus has been attained. This can be maintained only for 2-3 days. Chlorella water have to be supplied as feed. After 4-5 days, water becomes transparent again depending upon the amount of Chlorella water supplied. This procedure is

repeated to maintain the density of 100-300 individuals per ml of rotifer until the full capacity of the tank is reached. (Actually only half of its capacity could be utilized due to insufficient aeration). Brachionus is harvested by draining the culture water through a nylon bolting cloth No. XXX 25. In the mass culture of rotifer, it is very important to have a simultaneous culture of Chlorella in order to provide a continuous supply of green water as feed for the cultured Brachionus.

4. Mass Culture of Marine Chlorella

At the start, seawater is admitted in the open tank with a capacity of 360 tons up to 1/5 of its capacity and aerated. Chlorella starter with a density of 15-20 million cells per cc is applied at the rate of 5-10% of total volume and the following commercial fertilizer is also applied.

21- 0-0	100 ppm
46- 0-0	10-15 ppm
16-20-0	10-15 ppm

As the Chlorella multiplies water is added gradually and the fertilizer replenished. Generally, the fertilizer is applied 3-4 times a month depending upon the density of Chlorella.

Table 1. Schedule of feeding in the rearing tank

Day	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
Stage		Zoea				Mysis				Postlarvae				
Bread yeast	0.2g /ton													
*Diatom x10^3/ml	5 to 10				10 to 15					10 to 20				
Rotifer						3 to 5 individuals/ml								
**Naup. of brine shrimp									50 inds/Larvae/day					
Shrimp meat											3-500g/1M larvae/day x 4			

* In case of diatom shortage, artificial feed (Kyowa Hakko Co) is used as supplemental feed as follows:

Standard amount and size of crumble of Artificial feed

Stage	Sieve	Amt./Larvae x 1 10^6/day
Zoea	150 mesh	5-10g x 4
Mysis P-2	120 - 150	15-35g x 4
P-3 to P-7	80 - 120	40-70g x 4

** 1g Brine shrimp eggs is equivalent 300,000 eggs

1. Production Record

The hatchery produced a total of 5981 million postlarvae in 1977 at an average monthly production of 665,000. The monthly production is shown in Table 2.

During the month of January and February, the hatchery was not in operation for repairs and maintenance of facilities and equipment due to continuous use during the previous year. Poor supply of spawners and low water temperature during these months made January and February the ideal time for closing down. The operation started March 20, when spawners were first available.

2. Spawner Supply

Monthly spawner supply in 1977 is shown in Table 3. 1308 spawners were used for the mass seed production in Hatchery out of 1728 spawners supplied. The other 420 spawners were either dead on arrival, week, or were used by the other projects
On the month of July the broodstock in Batan finally was in a position to provide ablated spawners regularly. Of the total spawner supply, 89% came from the broodstock, with only 11% wild. The composition by source and by maturity is compared with the 1976 spawner supply in Table 4. The average number of nauplius per spawner was 77.180, production per spawner was 4,600 postlarvae. In 1976, only wild spawners were utilized for seed production but in 1977, ablated spawners constituted 89.0% of the total.
There were more stage 4 spawners in 1976, than in 1977 (41% against 24.5%). However, the proportion of spawners which failed to spawn was higher in 1976.

3. Summary of Operation

49 operations were done in 1977 including 9 experimental operations using 50-ton Indoor tanks. Table 5 shows the record of tank

usage and total production by tanks. 4 tanks of the 200-ton outdoor tanks and three 120-ton tanks were used for mass seed production. In 1976, results had been consistently better in the outdoor tanks. The operation were, therefore, concentrated among the 4 outdoor tanks. In the first half of the year, only 2 tanks (CT-15, CT-16) were used for larval rearing, the other two (CT-13, CT-14) were used for algal culture until the algal tanks were completed at the end of July. The tnak with the best record is CT-16 which produced 60.6% of the total production. An average of 166,400 postlarvae per operation was attained, this year. The production of 120-ton indoor tanks was very poor due to poor air supply was still insufficient during 1977 and the construction of the agitator for indoor tanks was partially completed only on October. Only 40,000 postlarvae or 0.7% of the total production were produced using the 120-ton indoor tanks.

Survival Rates

The record production of 1.62 million postlarvae harvested from one tank was attained on September 16, 1977. The previous record was 1.3 million in 1976. This represented a survival rate of only 31.6% in contrast with 76.8% in 1976. The 1976 percentage survival record therefore remains. This year our highest survival rate was only 40.3%. Survival rates of the best runs of 1977 are compared with that of 1976 in Table 6. Management procedures between the successful operations are compared in Table 7.

Overall the average survival rate was a low 6%. Many of the larval loses were due to explainable factors, Table 8. The most disastrous loss that of 16 million nauplii at one time was a case of the hatchery being totally unprepared for the arrival of the 165 spawners. At that time the Batan substation radio was not yet operational. No advance notice of the arrival of spawners was received. Thus all of the 165 spawners were stocked in the only

tank available. With a total of 19 million eggs, in one tank the result was disastrous. Attempts were made to transfer some of the nauplii to other tanks soon as these were made ready, but to no avail. In general, tanks stocked with more than 7 million eggs, except for one instance never reached the harvest stage.

The fungus Lagenidium was often the immediate cause of mass mortalities. However, other external factors such as poor water quality and lack of diatoms for feeding is believed to cause the larvae to weaken and become less resistant to the fungus. In a few instances, including the record breaking operation with 1.6 million harvested, Lagenidium appeared at very low level (4%) during the first zoea stage, only to disappear after molting. When the initial infection rates are higher than 10%, generally the disease multiplies rapidly and the larvae never recover.

With the cooperation of the Pathology project, prophylactic measures were instituted. Spawners were treated in different anti-fungal agents. Furanace, formalin, and sodium hypochlorite were assessed. The spawning performance and larval viability did not appear to be affected by chemical treatment. However, the results are still too limited to provide an over-all assessment on the effect of spawners treatment on larval survival.

Problems were encountered during the typhoon months when strong wind and wave action churns up the shallow subtidal areas where the seawater intake pipe is located. During this time the seawater is too muddy for the filter to work effectively. During this period, it is impossible to maintain the larval rearing water at the desired level of clarity, and hatchery operations are often aborted.

Experimental Operations Using 50-ton Tanks

Nine runs were conducted using the 50-ton indoor tanks. Limited experiments on the modification and refinement of larval rearing procedures were conducted. Production of fry of other penaeid species is also undertaken in these operations.

In 1977, 85,000 P. merguiensis were produced with a survival rate of 62.1%. Our normal operating procedure involves the frequent monitoring and pumping of diatoms round the clock. In order to simplify the procedure, experiments were made on the deliberate over-stocking of diatoms in order to supply food for a longer period of time, expecially during the night, without frequent replenishment. The results are still variable and inconclusive.

Problems Encountered:

1. Difficulty of the maintenance of good quality and condition of the rearing water in the large tank due to the following matters.

   a) Shortage of freshwater supply for controlling the optimum salinity range, especially during dry seasons.

   b) During rainy seasons, seawater along the seashore which is pumped up to the Hatchery is so turbid due to rain and Southwest monsoon. Our present filter system cannot support enough filtered water to 8 large tanks (total 1,280 ton), in case of full operation.

   c) Impossibility of cleaning the seawater pipes due to lack of drain valves. The cleaning of pipes for all possible fouling organisms and debris should be done regularly otherwise there is a possibility of its becoming a hot bed of disease-carrying organisms.

   d) Sudden changes of salinity and water temperature due to typhoon in the outside tank during rainy season.

   e) Low water temperature during the month of January and February.

2. Defect of aeration system

Although the new roots blower is in place, air supply is still insufficient due to leaks in the pipes especially those located under ground. Unless we renovate our piping system completely, even another roots blower cannot solve the problem. Furthermore, water often finds its way to the aeration pipe -- this is another disease vector.

3. Contamination in the rearing tanks due to construction and repair work of hatchery facilities

During the whole of 1977 some construction or repair work were always in progress in the indoor hatchery.

4. Disturbance of Hatchery operation due to visits by unauthorized persons.

5. Larvae with fungul infection.

6. Lack of diatoms due to bad weather conditions and delay of construction of algal tank. In case of full operation the present 10 units of algal tanks will not be capable of supporting 8 rearing tanks.

7. Electrical and engineering troubles and safety

Some electrical equipment (sumersible, pump, agitators, switches, etc.) are grounded or out of order. Minor electrical accident which could have been serious have already occured.

8. Unexpected arrival of spawners.

9. Other matters which can be considered as time/effort saving in nature, these are:

a) Improvement of present system for controlling light intensity using layers of black net.

b) Bridge from outdoor tank to algal tank
c) Shade for harvesting area of rotifer tank
d) Toilet and locker room for hatchery staff
e) Rest room for night duty
f) Special room for microscope and sensitive equipment

Recommendations

1. Unless the freshwater supply is improved, the hatchery will be forced to use one rearing tank for freshwater storage in order to have freshwater available when needed.

2. A seawater well will supply clear seawater which will no longer need filtration.

3. The seawater pipes should be provided with clean-out valves if possible. If not possible a system of flushing the entire system with calcium hypochlorite or other disinfectant regularly should be instituted.

4. All aeration pipes that are located under concrete pavement should be condemned and replaced with exposed pipes. Check valves should be installed at critical places in order to prevent water from being sucked into the pipe everytime the roots blower goes off or is turned off for servicing.

5. During the months of January and February when the temperature gets below the optimum for larval rearing the hatchery can be closed down and major repairs works done.

6. All metal supports for water and aeration pipes should be inspected for extent of corrosion and those which are found weak replaced or strengthened.

7. Electrical system, outlets/switches should be waterproofed.

8. A bridge be constructed from the outdoor tanks to the algal tanks.

9. The hatchery should be provided with a toilet/locker area.

Table 2. Monthly production of postlarvae and number of spawners used in 1977

Month	No. Spawner	No. Harvested
January	-	-
February	-	-
March	-	-
April	48	735,000
May	36	170,000
June	23	86,000
July	290	1,090,000
August	341	916,000
September	81	1,706,000
October	286	860,000
November	135	170,000
December	68	248,000
TOTAL	1,308	5,981,000

Note: The monthly figures for the spawners used in this table are matched with the harvest date of the respective postlarvae produced and does not refer to the actual month when the spawners were delivered. It will, therefore, differ from the monthly spawner supply record which is based strictly on delivery date.

Table 3. Spawner received by month, by maturity, by nature of spawing, and source in 1977

	Total	S-4	S-3	Total	S-4	S-3	DOA	No. Spawners used	Nature of Spawning 1/ CS	PS
March	3	1	2	23	9	8	1	24	4	9
April	28	14	14	32	13	19	0	55	15	23
May	13	5	8	26	8	18	2	28	9	14
June	23	6	16	31	11	15	3	51	18	14
July	19	8	9	383	40	187	36	327	123	118
August	25	11	9	376	64	194	3	334	104	86
September	2	1	1	211	66	94	12	128	45	41
October	70	38	32	262	75	182	19	218	89	57
November	7	0	7	153	39	88	7	192	21	17
December	0	0	0	41	1	3	0	41	14	5
Total	190	84	98	1,538	326	808	83	1,308	442	382
% to Total	11.0	44.4	51.9	89.0	22.0	44.6	4.8	75.2	35.8	30.9

1/ Nature of spawning of 73 spawners were not determined. CS: Complete spawn. PS: Partial spawn.

Table 4. Comparison between spawners received in 1976 and 1977

	Year 1976	1977
Total No. Spawner Used	1378	1308
Source: Wild	100%	11%
Ablated	0%	89%
Maturity: Stage 4	41.0%	24.5%
Stage 3	27.0%	54.3%
Others	32.0%	21.2%
Spawning: Complete	17.2%	35.8%
Partial	33.8%	30.9%
Unspent	49.0%	33.3%

Table 5. Record of tank usage and total production by tank in 1977

Tank No. (Month)	Total No. of Oper.	Total No. of days	Total ($\times 10^3$) production	% to total production
Outdoor (200-ton)				
CT-13	5	47	319	5.3
CT-14	8	61	299	4.9
CT-15	8	107	1,197	19.7
CT-16	12	175	3,677	60.8
Indoor (120-ton)				
CT- 9	2	22	0	0
CT-10	2	27	40	0.7
CT-11	3	27	0	0
Indoor (50-ton)				
CT- 4	5	85	380	6.3
CT-5	4	66	154*	2.5
TOTAL	49	617	6,066*	100.00

The production per operation of 200-ton outdoor tank: 166,400
per 120-ton Indoor tank : 5,700
per 50-ton Indoor tank : 66,800

* Including 85,000 P. merguiensis

Table 6. Comparison between the best operations of 1976 and 1977. In 1976 best survival and production coincided in the same operation.

	1976	1977	
	Survival & Prod.	Survival	Production
Tank No.	16	16	16
No. Spawners	21	20	51
Duration	9/25 - 10/15	6/17 - 7/2	8/30 - 9/15
Eggs	2,760	1,800	5,490
Nauplius	1,760	1,540	5,120
$Zoea_1$	1,680	1,200	4,390
$Mysis_1$	1,720	1,200	3,310
$Postlarva_1$	1,270	940	2,330
$Postlarva_5$	1,490	620	1,620
Harvest	1,352	620	1,620
Stage	P_{10}	P_5	P_5
% Survival from Nauplius	76.8	40.3	31.6

Table 7. The comparison of the best production and survival rate run of the year 1976 and 1977

	Temperature		Salinity		Diatom (10^3 cells/ml)	
	Low	High	Low	High	Low	High
1976, Best Production and Survival						
Egg	27.6	27.9	31	31	0	0
Nauplius	27.4	28.8	30	32	0	0
Zoea	27.0	28.0	29	31	1	21
Mysis	27.6	29.0	29	30	0	10
Postlarva	28.0	29.0	29	30	0	6
Feeding: Brachionus	Z_3 up to $P_{3,4}$					
Shrimp meat	M_3 up to $P_{5,6}$					
1977, Best Survival						
Egg	27.0	27.0	34	34	0	0
Nauplius	27.0	27.0	34	34	0	0
Zoea	27.0	27.3	34	34	14	86
Mysis	26.8	28.0	33	34	20	70
Postlarva	26.5	28.0	32	34	0	36
Feeding: Brachionus	Z_3 up to $P_{3,4}$					
Artemia	M_3 up to $P_{3,4}$					
Shrimp Meat	P_1 up to $P_{4,5}$					
1977, Best Production						
Eggs	26.5	26.5	33	33	0	0
Nauplius	25.0	25.0	32	32	0	0
Zoea	24.5	25.0	26	29	6	42
Mysis	25.0	26.0	26	28	0	36
Postlarva	25.0	26.0	26	29	30	84
Feeding: Brachionus	Z_3 up to $P_{3,4}$					
Artemia	P_1 up to $P_{3,4}$					
Shrimp Meat	P_1 up to $P_{4,5}$					
Artificial feed supplemented in case of diatom shortage.						

Table 8. Summary of hatchery operation in 1977
Eggs, nauplius and postlarval numbers in thousand

Oper. No.	Tank No.	Date Began	Date Harvest	SP Used	Egg Count	Nauplius	Harvest		Remarks
H_1	CT_{16}	3-21-77	4-06-77	13	1,800	1,470		210	
								50	
H_2	CT_{15}	3-26-77	4-14-77	5	770	690		25	
								250	
H_3	CT_9								
H_4	CT_{16}	4-07-77	4-19-77	30	1,720	1,440	P_1	200	Mysis 3 w/ Lagenidium
H_5	CT_{15}	4-18-77	5-04-77	16	1,040	1,620			M_2M_3 w/ Lagenidium added nauplii from FGT
H_6	CT_{16}	4-20-77	5-03-77	9	300	290			M_3 w/ Lagenidium
H_7	CT_{16}	5-18-77	6-01-77	23	1,470	1,520			Spawners used for 2 days spawning: M_3 w/ Lagenidium
H_8	CT_{10}								
H_9	CT_{16}	6-17-77	7-02-77	20	1,800	1,540	P_4P_5	620	
H_{10}	CT_{15}	7-07-77	7-23-77	20	3,600	1,270	P_5P_6	470	Nauplii taken from FGT I in Wet Lab.
H_{11}	CT_{16}	7-15-77	7-25-77	61	8,000	6,120			Zoea 2 w/ Lagenidium zoea took 6-7days before Molt to mysis
H_{12}	CT_{14}	7-18-77	7-22-77	12		760			Nauplii from FGT; some nauplii took 4 days before molting to zoea; Zoea I w/ Lagenidium
H_{13}^1	CT_{13}	7-22-77	7-25-77	146	19,000	16,180			Eggs spawned in CT_{13} but nauplii divided into 3 tanks; Zoea w/ Lagenidium
H_{13}^2	CT_{14}	7-24-77				700			Nauplii from CT_{13}; Zoea I w/Lagenidium

Table 8 (cont'd)

Oper No.	Tank No.	Date Began	Date Harvest	SP Used	Egg Count	Nauplius	Harvest	Remarks
H_{13}^{3}	CT_{15}	7-24-77	7-25-77			1,360		Nauplii from CT_{13}; Zoea 1 w/ Lagenidium
H_{14}^{1}	CT_{16}	7-29-77	8-16-77	45	3,970	2,910	P_6P_7 431	
H_{14}^{2}	CT_{15}	7-19-77	8-16-77	43	2,340	1,970	P_6P_7 331	
H_{15}^{1}	CT_{13}	8-15-77	8-18-77	50	6,110	5,450		Nauplii w/ Lagenidium
H_{15}^{2}	CT_{14}	8-15-77	8-19-77	50	7,470	4,470		Nauplii w/ Lagenidium
H_{16}	CT_{11}							
H_{17}	CT_{15}	8-20-77	8-31-77	13	3,100	1,430	P_1P_2 87	
H_{18}	CT_{16}	8-21-77	8-23-77	19	3,050			Agitator was out of order leaking oil into rearing tank
H_{19}^{1}	CT_{13}	7-21-77	7-24-77	97	2,480	240		Poor hatching rate due to low salinity
H_{19}^{2}	CT_{14}	8-21-77	8-24-77		2,980	220		Poor hatching rate due to low salinity
H_{20}	CT_{16}	9-21-77	10- 7-77	52	7,100	5,080	P_3P_4 447	Some zoea took 6 days before molting to Mysis
H_{22}	CT_{15}	9-27-77	10- 1-77	51	10,260	6,280		Zoea with Lagenidium
H_{23}	CT_{15}	10- 5-77	10-20-77	72		3,700	P_4P_5 300	
H_{25}	CT_{14}	10-14-77	10-27-77	39	NC	2,000	P_4P_5 300	
H_{26}	CT_{13}	10-28-77	11-14-77	60	5,000	2,190	P_4P_5 71	
H_{27}	CT_{14}	11- 4-77	11-18-77	28	3,180	2,390		Eggs and nauplii transported no spawners sent very low water temp.; mysis took 3 days more before molting

Table 8 (cont'd)

Oper. No.	Tank No.	Date Began	Date Harvest	SP Used	Egg Count	Nauplius	Harvest	Remarks
H_{28}	CT_{16}	11-11-17	11-28-77	47		880	P_4P_5 99	Eggs from Batan; used Tetraselmis used when no diatoms available
$H_{29}{}^{1}$	CT_{13}	11-18-77	12-03-77	52	1,320	1,160	P_4P_5 248	
$H_{30}{}^{2}$	CT_{14}	11-28-77	11-29-77	15	3,640			Zoea 1 w/ Lagenidium
$H_{31}{}^{2}$	CT_{16}	12-04-77	12-20-77	23	2,340	1,850		Mysis 1 w/ Lagenidium
$H_{31}{}^{2}$	CT_{16}	12-04-77	12-20-77	14	4,700	3,570		Mysis 3 w/ Lagenidium

Dr. Chhorn Lim

Station Head
Tigbauan Research Station
SEAFDEC Aquaculture Dept.
Tigbauan, Iloilo

Dear Dr. Lim:

I am pleased to submit herewith my report on the studies I have undertaken together with other Department staff during my assignment to the SEAFDEC Aquaculture Department.

It is hoped that the results of these studies will be helpful to the improvement of the technology on prawn.

I also wish to take this opportunity to express my gratitude for the cooperation extended to me by the Department staff.

Very truly yours,

Y. NUKIYAMA

cc: Office of the Chief
Office of the Deputy Chief

June 1980

The mass production of Penaeus monodon postlarvae in the large-scale hatchery, SEAFDEC Aquaculture Department

by Y. Nukiyama

I. Introduction

The culture techniques developed in Japan for Penaeus japonicus were adapted in the initial operation of the SEAFDEC prawn hatchery for the mass seed production of Penaeus monodon. This method known as the ecosystem or community culture involves the culture of natural food (like Skeletonema costatum, Chaetoceros sp. and other species of diatoms) and culture animals in the same tank. It requires the maintenance of good diatom growth for a long period in the rearing tanks by fertilization and water management. It was found, however, that this method was not suitable for the culture of P. monodon in the SEAFDEC hatchery because of the difficulty in maintaining good growth of the natural food in the tanks.

In a tropical environment like the Philippines, it was observed that abrupt increase of diatom density and collapse of the same was due to intense illumination which consequently led to the deterioration of water quality and mass mortality of larvae. There was, therefore, a need to develop culture techniques suitable to tropical environment.

II. General considerations on the mass seed production of prawn larvae

A. Feeds and feeding

The results of several hatchery runs showed that live diatoms are best for the prawn larvae. This is because of their suitable size, high nutritive value and uniform distribution in the water. Some diatoms are also believed to have purifying effects upon water quality.

In the SEAFDEC prawn hatchery, the diatoms Skeletonema costatum and Chaetoceros sp. are found to be superior to other species for the mass production of prawn postlarvae. These species are cultured separately in large concrete tanks instead of rearing them together with the culture animals as in the ecosystem culture method in order to maintain the desired diatom density. After the blooming of diatoms, the cells are concentrated by passing through a sand filter before feeding to the larvae. The diatom density in the rearing tank is maintained by the following measures:

1) non-fertilization of the water in the rearing tanks.
2) installation of black cloth to control light intensity because Skeletonema becomes weak when subjected to strong intensity.
3) introduction of Tetraselmis and Chlorella.

In case of overblooming of diatoms, the addition and/or change of water in the tanks is done to dilute the dense diatoms.

Diatom density is also very important in larval rearing. The concentration of 5-10 x 10^3, 15-30 x 10^3 and 20-50 x 10^3 cells/ml were observed to be the optimum for Z_1, Z_2 and Z_3, respectively. Table 1 shows the survival of P. monodon larvae using different diatom densities in the indoor and outdoor tanks. It was likewise observed that lack of diatoms was less harmful to the larvae than excess of it.

Although prawn larvae can be reared fairly well up to postlarvae on diatoms alone, it was observed that a combination of two or more diets give better results. Table 2 and 3 show the results of different diet combinations on survival of prawn larvae. The following are the evalutions and preparations of the individual feeds tried:

1) lablab/lumut/Sargassum - the juice of any of these is extracted for feeding zoea; difficult to collect sufficient amount; preparation for feeding is laborious.

2) coconut meat - entails a lot of labor; makes the water transparent because particles adhere to the meat.
3) Tetraselmis - effective food but the mass production is a problem since it takes relatively longer time to reach the peak; difficult to concentrate enough amount for feeding.
4) Chlorella - does not contribute directly to the diet of the larvae but for Brachionus; has purifying effects upon water quality.
5) bread yeast or cultured yeast - used as food supplement when diatom is insufficient at Z_1; easily pollutes water in uncontrolled amount; expect secondary products for feed.
6) brine shrimp nauplii - very efficient food for postlarvae but expensive; purchase is difficult because it is not locally available; substantial amount of nauplii can be introduced earlier which serves as a food for P_5-P_7.
7) mussel meat - found to be good feed but if washings are not done well, diatoms will bloom; careful preparation should also be observed.
8) tuna or gizzard fish - not so good for they remain floating on water.
9) shrimp - good but expensive; entails a lot of preparation.
10) artificial feed (Kyowa Hakko) - good feed; pass through nets to suit the sizes preferred at different stages.

The efficiency of various feeds for each larval stage is shown in Table 4. Optimum amount to be fed at different stages is presented in Table 5. Based on the various feeding trials, the large-scale hatchery has developed a better procedure (Table 6) which is being used at present. It is also believed that feed is not the only factor that affects survival and growth of the larvae.

B. Control of water quality

To avoid the deterioration of water quality in the course of larval rearing, daily water change was done during Z_3 or M_1. However, better results have been obtained by transferring the larvae to other tanks. Transfer of larvae from indoor (120-ton tanks) to outdoor (200-ton tanks) is done after they have metamorphosed to M_1. Results of mysis transfer and non-transfer is shown in Table 7. Three to five days prior to larval transfer, Brachionus and Chlorella are cultured and allowed to bloom in the outdoor tanks where the larvae are to be transferred.

C. Physico-chemical parameters

The quality of the rearing water in the culture tanks is very much affected by the prevailing water condition of the seawater source. Figure 1 shows the monthly average of salinity, temperature and rainfall. General observations during the dry season showed that a temperature of 27 to 29°C and a salinity of 32-35 ppt is not difficult to maintain for zoea to mysis stage in indoor tanks. High survival is attained when a salinity of 26-29 ppt occurs during rainy season at postlarval stage in the outdoor tanks. Table 8 shows the survival of P. monodon larvae during dry and rainy season. As shown in Figure 2, higher production of prawn postlarvae was obtained during rainy season. But heavy and long rain caused higher mortality because temperature decreased and consequently, delayed the molting of the larvae. In addition, natural feeds will not bloom.

D. Larval stocking density

Table 9 shows the survival of larvae from nauplius to postlarvae at different stocking densities. In general, low stocking density is better than higher stocking density. The optimum density for nauplius to mysis is 8,000 to 16,000/m^3 and mysis to postlarvae is 5,000 to 7,500/m^3. The stocking density also depends on the availability of nauplii from source.

E. Diseases

It has also been observed that diseases occur when water condition is poor and the larvae are weak. Mass mortality of larvae is attributed to fungal infection. Fungal infection is suspected to be caused by Lagenidium sp. In 1977, 30 out of 43 runs were infected with Lagenidium and 17 out of these 30 runs were discarded. Malachite green has been tried as prophylactic agent but it was found not effective because larvae were also affected. When fungal infection was observed, more than half of the water volume in the rearing tanks were changed daily. However, prevention is more important so that the tanks are chlorinated with 15 ppm calcium hypoclorite before stocking with water for larval rearing. The maintenance of a good water quality and the control of feeds to the desired concentration should be observed to produce strong larvae, thus, will not easily be attacked with fungal infection and other diseases.

III. Conclusions and recommendations

After years of hatchery trial runs, the mass seed production technology for prawn has been evolved that suits the prevailing conditions in the Philippines. It is a modification of the method developed by the Japanese workers for the mass seed production of P. japonicus. Thus, the species difference and the ecological requirements of an organism should be effected with due consideration in the adaptation of technology.

At present our technology is still much dependent on the skill of workers rather than the established methods or procedure. The success or failure of hatchery runs is influenced by the dedication and skill of the workers. It would therefore be necessary to provide a favorable working environment and proper motivations to the workers for the productive operation of the hatchery. Thus, it is advisable to stagger hatchery operations in order to give more time for the personnel in assessing and evaluating the hatchery results rather than having operations for the whole year.

Although the present technology for prawn seed production is fairly established, its transfer to the private sector is still not practical due to the high cost of initial investment and operational expenses. It is therefore necessary to scale down the technology developed in large-scale tanks into small-scale in order to transfer the technology easily to the industry. However, in the near future when the technology for the large culture is further simplified, supply of spawners or nauplii becomes abundant and demand of artificial fry increases, the adaptation of large-scale technology becomes imperative.

Table 1. Survival of Penaeus monodon reared in indoor and outdoor tanks using different diatom densities

TRIAL	Stocking Density x 10^5	Indoor $Z_1 - M_1$ Diatom density c/cc			Outdoor $M_1 - P_1$ Diatom density c/cc			Outdoor $P_1 - P_5$ Diatom density c/cc		
		Range	Ave.	% S	Range	Ave.	% S	Range	Ave.	% S
1	7.3	0- 70	24	95.9	0- 88	28	38.6	40-266	101	72.2
2	41.0	0- 90	24.5	31.8	8-170	52	27.3	6-196	47.8	45.4
3	7.0	4- 52	16	95.8	8-120	45	60.3	26-133	61	68.8
4	23.5	4- 56	24	62.1	0- 6	0.4	29.8	0- 20	3	46.8
5	10.8	6- 44	19.2	58.3	6- 62	24	66.7	16- 78	48	98.8
6	15.1	2- 64	27	80.1	6- 42	22	86.4	2- 48	27.1	57.4
7	10.2	12- 46	24	95.1	4-100	43.3	58.3	10- 68	36	100.0
8	24.5	4- 72	28	41.2	2- 82	24	72.4	2- 28	16	69.7
9	12.6	6- 46	19	57.1	5-140	44	62.0	10- 48	32	77.3
10	15.0	4- 54	33	85.3	10- 76	26	92.2	10- 76	30	77.1
11	22.6	6- 60	25	65.8	12-178	63	44.6	2- 36	19	68.2
12	10.2	10-106	36	72.5	10-376	90	100	2- 52	20	65.4

Table 2. Survival of Penaeus monodon using a combination of different feeds

	N	Z_1	M_1	P_1	P_5	Harvest
Stocking density (x 10^3)	1760	1690	1720	1270	1490	1350 (P_{10})
% Survival		96.0	100.0	73.8	100.0	90.6
Bread yeast						
Chaetoceros						
Brachionus						
Brine shrimp						
Shrimp meat						
Stocking density (x 10^3)	1800	1540	1200	1200	940	
% Survival		85.5	77.9	100.0	78.3	
Chaetoceros						
Brachionus						
Brine shrimp						
Shrimp meat						
Stocking density (x 10^3)	1010	740	730	890	610	
% Survival		69.3	100.0	73.6	68.6	M_1 combine
Skeletonema						
Brachionus						
Brine shrimp						
Artificial feed						
Stocking density (x 10^3)	1860	1850	1340	950	-	120 (P_{17})
% Survival		99.4	72.4	70.9	-	-
Natural diatom						
Bread yeast						
Lumut						
Brine shrimp						
Mussel meat						
Stocking density (x 10^3)	380	370	350	240	190	50 (P_{13})
% Survival		97.4	94.6	68.6	79.2	26.3
Nilzchia						
Brachionus						
Bread yeast						
Brine shrimp						
Mussel meat						

Table 3. Survival of P. monodon using a combination of different feeds

	N	Z_1	M_1	P_1	P_5	
Stocking density (x 10^3)	1150	1020	740	700	600	
% Survival		88.7	72.5	94.6	85.7	M_1 M_2 transfer
Skeletonema		▬▬▬	▬▬▬			before transfer
Brachionus			▬▬▬	▬▬▬	▬▬▬	
Tetraselmis				▬▬▬	▬▬▬	culture
Brine shrimp				▬▬▬	▬▬▬	
Stocking density (x 10^3)	370	350	330	330	180	
% Survival		94.6	94.3	100	54.5	indoor 50-ton
Skeletonema		▬▬▬	▬▬▬			
Cultured yeast			▬▬▬	▬▬▬	▬▬▬	
Brachionus			▬▬▬	▬▬▬	▬▬▬	
Brine shrimp				▬▬▬	▬▬▬	
Stocking density (x 10^3)	5120	4390	3310	2330	1620	
% Survival		95.1	75.4	70.4	69.5	
Chaetoceros		▬▬▬	▬▬▬	▬▬▬	▬▬▬	lack of diatom
Brachionus		▬▬▬	▬▬▬	▬▬▬	▬▬▬	
Artificial feed		▬▬▬	▬▬▬			
Brine shrimp				▬▬▬	▬▬▬	
Shrimp meat				▬▬▬	▬▬▬	
Stocking density (x 10^3)	900	1080	630	420	420	
% Survival		1-0	58.3	66.7	100	
Skeletonema		▬▬▬	▬▬▬	▬▬▬	▬▬▬	
Brachionus		▬▬▬	▬▬▬	▬▬▬	▬▬▬	M_1 transfer
Tetraselmis				▬▬▬	▬▬▬	
Brine shrimp				▬▬▬	▬▬▬	
Stocking density (x 10^3)	1790	1510	1210	1050	870	
% Survival		84.3	80.1	86.8	82.9	
Skeletonema		▬▬▬	▬▬▬			M_1 M_2 transfer
Brachionus			▬▬▬	▬▬▬	▬▬▬	
Tetraselmis			▬▬▬	▬▬▬	▬▬▬	
Brine shrimp				▬▬▬	▬▬▬	

Table 4. Feeding efficiency of different feeds.

Legend: Very efficient ◎
efficient ○
Can be used △
Cannot be used ×

Feeds Tested	Z_1	Z_2	Z_3	M_1	M_2	M_3	P_5	$P_{5<}$
Natural diatoms	○	○	○	○	○	○		
N. closterium	○	○	○	○	○	○		
Chaetoceros	◎	◎	◎	◎	○	○		
Skeletonema	◎	◎	◎	◎	○	○		
Lab lab	△	△	△					
Lumut	○	○	○					
Sargassum zostera	△	△	△					
Coconut meat	×	×	×	?	?			
Tetraselmis sp.		○	○	○	○	○	○	
Chlorella sp.	×	×	×					
Bread yeast	△	?	?					
Cultured yeast	△	△	△					
Brachionus			◎	◎	◎	◎	◎	
Brine shrimp nauplii						◎	◎	
Brine shrimp adult								◎
Mussel meat							○	○
Fish meat						×	×	
Shrimp meat				○	○	◎	◎	◎
Artificial feed		△	△					○

Table 5. Optimum amount of feeding at different stage of P. monodon

Feeds used	Stage	Feed density	
Brachionus	$Z_2 - M_1$	3-5 ind/cc	
	$M_2 - P_5$	3-10 ind/cc	
	$M_2 - P_{10}$	30-50 ind/cc	propagated using chlorella before transfer
Brine shrimp nauplius	$M_2 - P_5$	50-80 ind/larvae/day	
Mussel meat	$P_3 - P_7$	90-50g/100 x 10^3	larvae/day, 4x a day
	$P_8 - P_{11}$	60-120g	"
	$P_{12} - P_{20}$	130-200g	"
Shrimp meat	$Z_3 - M_2$	15-20g/100 x 10^3	larvae/day, 2x a day
	$M_3 - P_2$	30-60g	"
	$P_3 - P_5$	30-50g	"
	$P_6 - P_{10}$	50-100g	"
Artificial feed	$P_3 - P_7$	8-11g/100 x 10^3	larvae/day x 4 (80 mesh)
	$P_8 - P_{11}$	12-25g	" (60-80 mesh)
	$P_{12} - P_{20}$	26-40g	" (40-60 mesh)
	$P_{21} - P_{35}$	41-80g	" (24-40 mesh)
Supplemental feed (in case lack of diatoms)			
cultured yeast	Z	5 x 10^3 cells/cc	50-100 cc
bread yeast	Z	0.5g/ton/day (max.)	
artificial	Z	0.5-1g/100 x 10^3	larvae/day x 4 (150 mesh)
	$M_1 - P_2$	4-7g/100x 10^3	larvae/day x 4 (120-150 mesh)

Table 6. Present feeding procedure

	N	Z_1	M_1	P_1	P_5	
Stocking density (x 10^3)	1080	1020	970	1050	1110	
% Survival		94.4	95.1	58.3	100	
Skeletonema						
Brachionus						
Brine shrimp						
Stocking density (x 10^3)	300	270	130	-	-	90 (P_{26})
% Survival		90.0	48.1	-	-	69.2
Skeletonema						
Brachionus*						
Brine shrimp						
Chlorella**						
Artificial feed						

* a concentration of 50 ind/cc should be attained prior to M_1 transfer.

** to avoid blooming of diatoms.

Table 7. Comparison of larval transfer and non-transfer

				N	Z_1	M_1	P_1	P_5	N-P_5
Indoor	1977	No. of operations	x 10^3	6.500	5.640	3570	1480	359	
	6.3	6							
	-10.6		% Survival		86.8	63.3	41.5	24.3	5.5
Indoor to Outdoor	1978		x 10^3	20260	18450	1157	6093	5205	
	6.15	10							
	-930		% Survival		91.0	63.6	51.8	85.4	25.7

Table 8. Survival of Penaeus monodon larvae on dry and rainy in 1978

	Dry season (10 runs)		Rainy season (16 runs)	
Larval stage	Larval count	% Survival	Larval count	% Survival
N	14.42		20.26	
Z_1	12.84	89.0	18.45	91.0
M_1	6.53	50.9	11.751	63.6
P_1	4.278	65.5	6.093	51.8
P_5	1.265	29.6	5.205	85.4
$N - P_5$		8.7		25.7

Table 9 Larval stocking density

Nauplius density x10^3/120 tons	No. of operations	Survival Nauplius-Mysis I	Mysis I density x 10^3/120 tons
4000 - 4500	3	41.4%	1880
3500 - 3900	3	31.0	1180
3000 - 3400	9	27.8	870
2500 - 2900	5	44.4	1.260
2000 - 2400	3	50.2	1.113
1500 - 1900	10	56.9	981
1000 - 1400	12	66.5	781
500 - 900	12	61.4	487

Postlarva density x 10^3/200	No. of operations	Survival P_1-P_5	x 10^3/200 tons
2000 - 2400	3	8.0	177
1500 - 1900	-	-	-
1000 - 1400	8	49.2	557
500 - 900	9	57.6	432
200 - 400	10	71.4	214

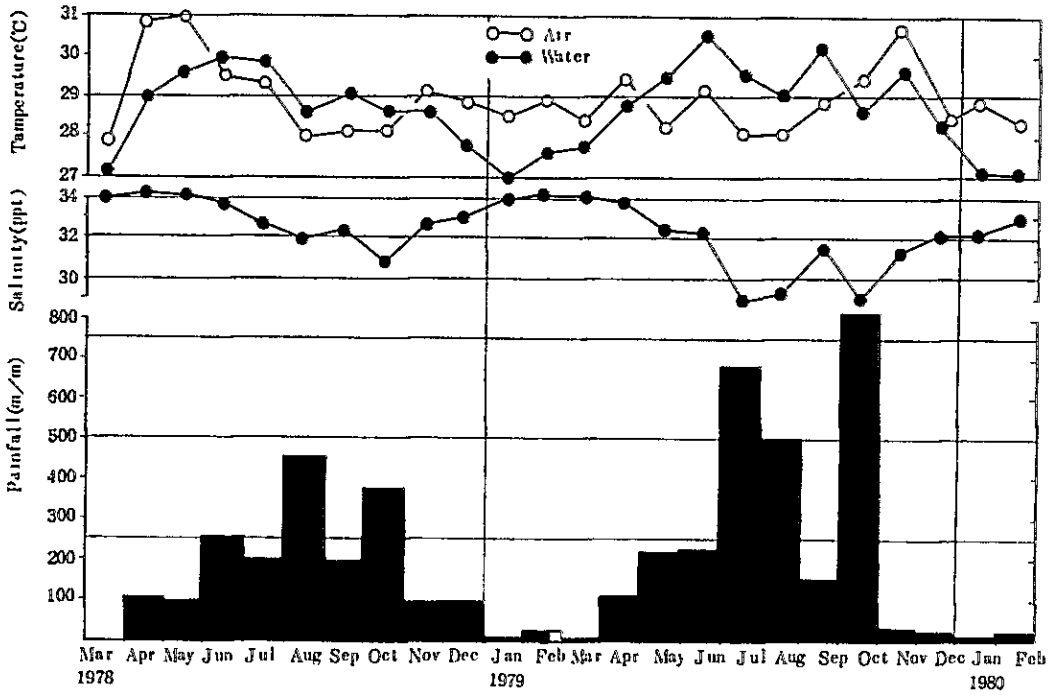

Fig.1. Monthly record of temperature, salinity and rainfall in SEAFDEC hatchery

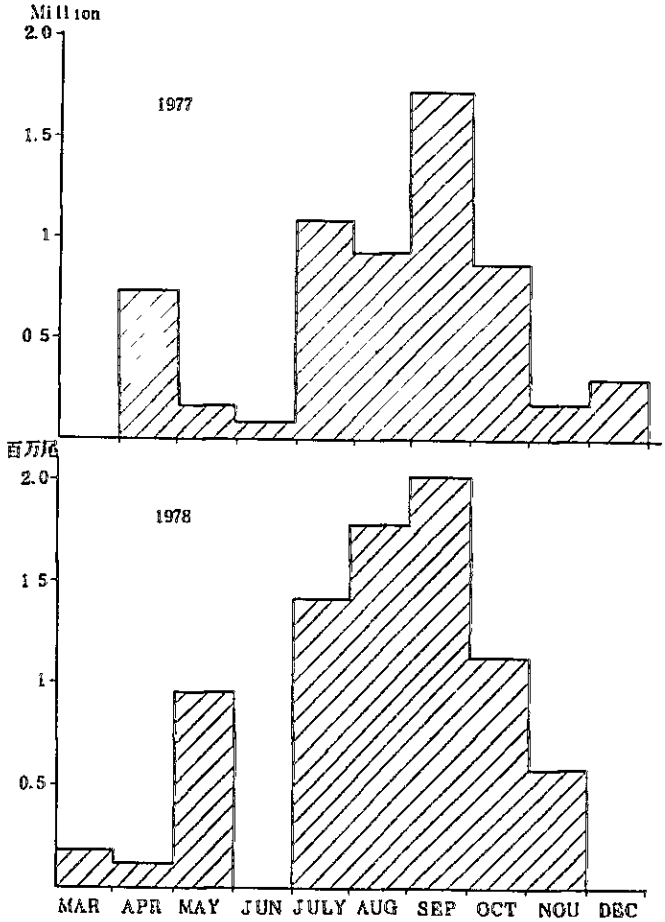

Fig. 2. Monthly production of P. monodon postlarvae in SEAFDEC atchery in 1977 and 1978